

Speciation analysis of Elements of Soil Samples by XRF in Gazipur industrial area, Bangladesh

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Abstract: About 20 topsoil samples collected from different locations of Gazipur industrial area were analyzed to specify the elements by XRF. Soil pH, moisture content, organic carbon, organic matter, elements were investigated by following proper procedure to find out the actual scenario of the soil status. Most soil samples pH is tend to neutral which is most favorable for up taking nutrients. Moisture Content, Organic Carbon and Organic Matter are enriched in the soil for plant growth. Speciation analysis are showing concentration trend as $Al > Fe > K > Mg > Ca > Rb > Mn > Si > P$. Most of the elements are used as fertilizer for soil nutrient supplement and also used as raw material in process industries. Though they are required for improving soil quality excess amount is also harmful for soil biota. Soil chemical reaction with the surrounding is largely controlled by the components present in soil matrix. Multivariate statistical analysis e.g: hierarchical cluster analysis showing 2 main clusters in the soil matrix which components are similar in characteristics or source. Group 1 and 2 formed by following different factors like common sources, attraction of the elements, similarity in characteristics. Correlation matrix is exhibiting significant positive relationship among the components. Different components have distinct positive relation with distinct components which differ from each other. Principal component analysis denotes 3 principal components for composing soil matrix significantly.

KEYWORDS: Correlation matrix, Custer Analysis, Industrial area, Major Elements, Principal Component Analysis

I. Introduction

Soil is an important source and reservoir for all kinds of elements and elements originating from geological sources or anthropogenic sources. Soil elements accelerated by the industrial development, urbanization, and population increase in the last decades, a large portion of areas are now containing destructive levels of pollutants including trace metals (CPCB, 2004). The geochemical composition of sediments is used for indicating anthropogenic pollution sources (Sheela et al. 2012). The natural pedo-geochemical background, which represents the concentration of metal derived from parent materials (Baize and Sterckeman, 2001); and anthropogenic contamination, which can involve direct deposition on soil (slag and smelter dust) and agricultural inputs like agrochemicals (Xue et al. 2003), mineral fertilizer (Gray et al. 1999), compost (Pinamonti et al. 1997), sewage sludge (Cornu et al. 2001), or diffuse contamination via organic or inorganic aerosol deposition on soil surface (Hernandez et al. 2003) are the major sources of different elements in soil. Agricultural soil contamination with major and trace elements through the repeated use of untreated or poorly treated wastewater from industrial establishments and application of chemical fertilizers

and pesticides is one of the most severe ecological problems in Bangladesh. Although some trace elements are essential in plant nutrition, plants growing in the close vicinity of industrial areas display increased concentration of heavy metals, serving in many cases as bio monitors of pollution loads (Mingorance et al. 2007). Vegetables cultivated in soils polluted with excessive trace and major elements take up and accumulate them in their edible and non-edible parts in quantities high enough to cause clinical problems both to animals and human beings consuming the trace metal-rich plants as there is no good mechanism for their elimination from the human body (Alam et al. 2003; Arora et al. 2008; Bhuiyan et al. 2011). Industrial activities discharge untreated or poorly treated industrial wastewater, effluent and even sludge into the surrounding environment that can decrease soil quality by increasing concentrations of pollutants such as heavy metals, resulting in adverse effects on macrophytes, soil fauna and human health (Ahmed et al. 2009; Mortula et al. 2002; Mahfuz et al. 2004; Rahman et al. 2008). Soil parent materials and pedogenesis clearly have a key influence on metal ambient background concentration (ABCs) (Palumbo et al. 2000; Baize and Sterckeman, 2001; Rawlins et

al.2003). The geochemical characterization of the soils is environmentally important, because the high concentrations of geochemical constituents in soil may enhance the levels of toxic metals as well as it can reduce soil fertility and finally it can increase input to food chain, which leads to accumulate toxic metals in foodstuffs and ultimately can endanger human health (Madrid et al. 2002).

II. Materials and Methods

2.1 Description of the Study Area

Gazipur District is located at just north of capital city of Dhaka, Bangladesh. Gazipur District is occurring between 23°53' to 24°20' North latitudes and between 90°09' to 90°42' east longitude. The total area of the district is 1806.36 sq. km of which 17.53 sq. km was riverine and 273.42 sq.km.is forest area (District Statistics Gazipur 2011).The Gazipur cluster lies on the southern corner of Madhupur tract with its average thickness of about 10 m consists of over consolidated clayey slit and is underlain by the

Pleistocene Dupi Tila formation. The basin has got the record of rapid subsidence and sedimentation (DoE & LGED).Two upazilas, namely, Gazipur Sadar and Kaliakair of Gazipur district were selected for study.

2.2 Sample Collection

Total 20 samples were collected at depth of 0-15 cm from the two targeted industrial upazilas of Gazipur district, Bangladesh, shown in **Figure 1**. Soil samples from various places of Gazipur such as housing estates, fields, agricultural land, and main roads were analyzed. Sample locations are determined by hand GPS (model no-GPS map 62 GARMIN).Samples were then divided into 8 in number and were mixed homogenously. Samples were preserved in polythene bags and prepared for EdXRF. The samples were air-dried, ground and passes through 2 mm sieve for mechanical analysis and through 0.5 mm sieve for chemical analysis.

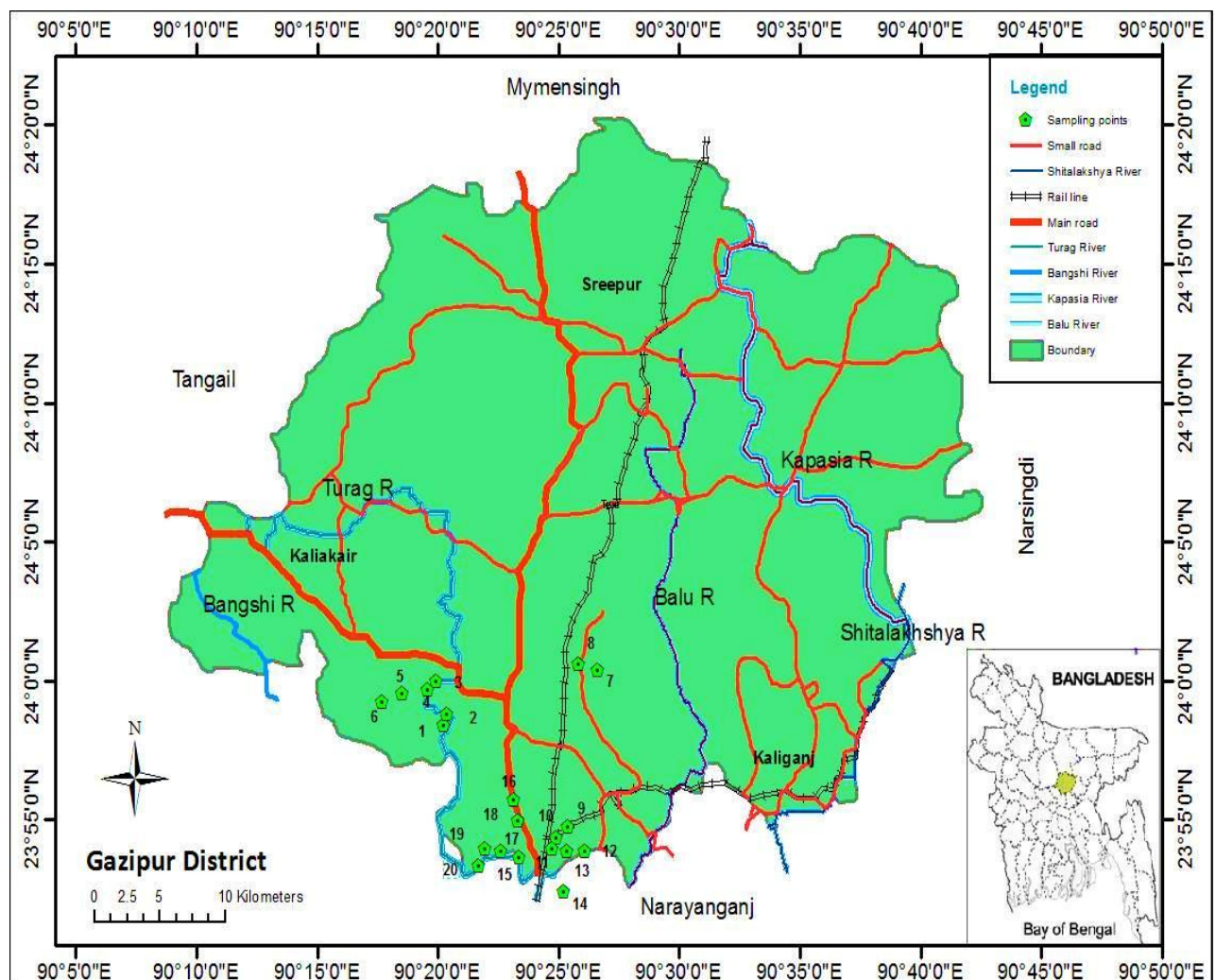


Figure1: Sample Location of the study area

2.3 Methods

Soil pH was measured electrochemically by using corning glass electrode pH meter (Model-7) from a soil suspension (Soil:water=1:2.5) as suggested by (Jackson 1962). For the determination of pH, 10 gm of air-dried sample was mixed with 25 mL distilled water (soil: water at a ratio of 1: 2.5) then the solution was stirred thoroughly and after 25-30 minutes the reading was taken (Islam and Weil 2000). Organic carbon (OC) and organic matter (OM) of sediment samples were determined by Walkley and Black Oxidation Method (Gelman et al. 2011). 0.3g dry composite sample was taken in clean dry 250 ml conical flask. 10 ml 1N K₂Cr₂O₇ solution and 10 ml concentrated H₂SO₄ acid were added and kept for cooling with shaking about 30 minutes. After cooling 150 ml distilled water, 10 ml concentrated H₃PO₄ acid and 0.2 g NaF was added and cooled the solution. Then 3 ml diphenylamine indicator solution was added and the solution turned into deep violet. Titration was performed to titrate the excess chromic acid left in the flask with the help of 1N FeSO₄ solution from a burette. At the end point the color of the solution changed to deep bottle green. The amount of FeSO₄ solution required was recorded in the titration. A blank experiment in the same way with the reagent except sediment was run and recorded the amount of FeSO₄ solution required and find out the strength of FeSO₄ solution from this determination.

Organic Carbon and Organic Matter Calculation:

1000 ml of N K₂Cr₂O₇ solution = 1000 ml of N carbon = 3 g of carbon (eq. wt. of carbon = 12/4 = 3).

Or, 1 ml of N K₂Cr₂O₇ solution = 0.003 g of carbon

Thus the amount of carbon in sediment expressed as percent, oxidized by 1N K₂Cr₂O₇ solution was calculated as follows-

$$\text{Percent (\%) of organic carbon (OC)} = \frac{(B - T) \times f \times 0.003 \times 100}{W} \quad \text{Equation (1)}$$

Where,

B = Amount in ml of N FeSO₄ solution required in blank experiment

T = Amount in ml of N FeSO₄ solution required in experiment with sediment

f = Strength of N FeSO₄ solution (from blank experiment)

W = Weight of sediment taken

It has been estimated that only about 77% carbon in soil is oxidized by N K₂Cr₂O₇ solution. So, 0.003 should be multiplied by 1.3 to get the percentage of total carbon present.

$$\text{Percent (\%) of organic carbon (OC) in sediment} = \frac{(B - T) \times f \times 0.003 \times 1.3 \times 100}{W} \quad \text{Equation (2)}$$

The organic matter of soil was determined by multiplying the content of organic carbon (OC) with a factor 1.724 on the assumption that organic matter of average soil contains 58% of organic matter (OM).

Percent (%) of organic matter (OM) in sediment = Percent (%) of organic carbon

$$(\text{OC}) \times 1.72 \text{ (Van Bemmelen Factor)} \quad \text{Equation (3)}$$

Soil moisture content has been determined by oven-dry method. 30 gm sample has been weighted by analytical weight. Weighted sample were dried at 100⁰C temp. for 48 hours. After drying samples were cooled and then weighted. Difference between the initial and final weight has been determined. Percentage of the difference and initial weight ratio were calculated. Moisture content of the soil was determined.

$$\text{Percent (\%) of Moisture content} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} \times 100 \quad \text{Equation (4)}$$

1.4 Elemental Analysis

Total concentrations of geochemical variables in soil samples were measured by X-ray fluorescence spectroscopy (XRF) at the Institute of Mining, Mineralogy and Metallurgy, Bangladesh Council of Scientific and Industrial Research (BCSIR), Joypurhat following the procedures outlined by (Qishlaqi and Farid

2007;Goto and Tatsumi1996) through using Rigaku ZSX Primus XRF machine equipped with an end window 4 kW Rh-anode X-ray tube. The samples were mixed with binder (stearic acid: sample at a ratio of 1:10) and pulverized for two minutes. The resulting mixture was spooned into an aluminum cap (30 mm). The cap was sandwiched between two tungsten carbide pellets using a manual hydraulic press with 10 tons/sq. in for 2 minutes and finally pressure was released slowly. Measurements of major and trace elements were carried out using 40 kV voltage and 60 mA current and 30 kV voltage and 100 mA current, respectively. The Geological Survey of Japan (GSJ) stream sediments (JSD) series have been used as a standard in the analyses and the precision is found better than $\pm 5\%$ for all analyzed elements (Faisal et al. 2015).

III. Results and Discussion

Following sample collection section samples have been analyzed by using proper methods. Samples have been prepared for analysis. Samples are analyzed for pH by using pH meter, Moisture content manually, organic carbon and organic matter has been determined by titration method. Results found are represented in the following table:

Table 1: pH, Moisture content, Organic Carbon and Organic Matter

Sample ID	pH	Moisture Content (%)	Organic Carbon (%)	Organic Matter (%)
S-1	6.55	25.21	3.56	6.12
S-2	5.75	23.75	3.71	6.37
S-3	6.50	20.44	4.00	6.88
S-4	6.41	20.89	3.71	6.37
S-5	6.60	28.15	6.59	11.34
S-6	6.08	20.28	4.30	7.39
S-7	7.13	20.14	6.89	11.85
S-8	6.45	22.61	5.63	9.69
S-9	6.44	23.03	4.82	8.28
S-10	5.35	18.17	5.41	9.30
S-11	5.25	12.53	5.19	8.92
S-12	6.38	17.09	6.45	11.09
S-13	6.15	23.45	4.67	8.03
S-14	7.28	19.97	5.93	10.20
S-15	5.92	25.65	5.56	9.56
S-16	6.55	27.35	6.52	11.22
S-17	6.13	28.33	6.82	11.73
S-18	6.60	26.77	6.82	11.73
S-19	5.20	19.56	6.97	11.98
S-20	5.78	24.27	6.15	10.58
Average	6.23	22.38	5.49	9.43
Min	5.2	17.09	3.56	6.12
Max	7.28	28.33	6.97	11.98

3.1 pH

From the analysis it is indicating that pH value is mostly tend to neutral which average value is 6.23 and ranges from 5.2 to 7.28. Plant nutrient availability is greatly influenced by soil pH. With the exception of P, which is most available within a pH range of 6 to 7, macronutrients (N, K, Ca, Mg, and S) are more available within a pH range of 6.5 to 8, while the majority of micronutrients (Cu, Fe, Mn, Ni, and Zn) are more available within a pH range of 5 to 7. Metals (Cu, Fe, Mn, Ni, and Zn) are more available at low pH levels than high pH levels. This can cause potential metal toxicities for crops in acid soils.

3.2 SOM (Soil Organic Matter) and SOC (Soil Organic Carbon)

From the observation it can be concluded that Organic Matter are marginally rich in the soil samples. The concentration of SOM in soil generally ranges from 1 to 6 % of the total topsoil. Soil contains 12-18% SOC are generally classified as organic soil. Average value of Soil Organic Carbon and Soil Organic Matter remain in soil samples are 5.49 and 9.43% respectively. Range of organic matter of soil varies from 6.12 to 11.98 % and organic carbon ranges from 3.56% to 6.97%. Sources of Organic matter in the study areas may be from the organic load in water system discharged by industries which inundates the land during wet season and organic manures used in agriculture.

3.3 Moisture Content

Moisture content of the soil samples was tested which are showing values ranges from 17.09% to 28.33% and average value is 22.38%. From this test result, it is evident that the study area soil moisture condition is very much favorable for plants and biota growth. Moisture content is very much crucial for dissolving nutrients in the soil for availability of microbes and plants growth and development. It is determining factor of soil compaction, soil erosion and slope stability. The sources of moisture in soil are directly controlled by rate of precipitation and irrigation in agricultural field.

Statistical analysis show the description of the data produced during the analysis. Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Means and standard deviation used to describe central tendency and variation of the data (Pallant 2011) are given in the table in addition to the minimum and maximum values.

Table 2: Results of direct analysis of soil samples by XRF

Sample No	Mg (mg/kg)	Al (mg/kg)	Si (mg/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Fe (mg/kg)	Rb (mg/kg) (Simu et al.2016)	Mn (mg/kg)
S-1	17.43	99.61	273.13	0.9	34.49	22.79	65.63	196.8	1.22
S-2	20	100	288.76	0.84	33.01	17.53	64.13	169.83	1.1
S-3	18.8	89.01	283.59	0.84	31.11	20.37	65.53	16.38	1.11
S-4	10.69	92.23	285.43	0.78	32.07	18.86	64.1	208.39	1.24
S-5	14.46	87.21	296.21	0.91	31.56	20.43	61.04	16.38	1.05
S-6	3.29	129.14	279.05	0.37	25.93	5.1	68.21	252.98	0.65
S-7	3.07	152.98	268.83	0.33	24.65	4.12	54.21	277.55	0.37
S-8	4.88	120.38	285.6	0.41	30.8	8.52	58.89	235.8	0.61
S-9	6.79	121.51	280.68	0.39	30.77	7.57	59.69	207.85	0.47
S-10	7.85	110.54	293.06	0.71	27.11	9.05	53.63	172.8	0.53
S-11	5.2	101.39	297.78	0.85	27.13	13.01	56.39	193.5	0.64
S-12	5.87	116.27	292.64	0.68	28.59	8.48	53.25	212.94	0.73
S-13	10.29	117.93	283.86	0.44	32.65	7.1	54.13	216.58	0.51
S-14	3.31	119.5	302.09	0.48	25.6	3.88	46.49	176.54	0.42
S-15	3.5	78.69	336.91	1.65	24.44	6.98	43.69	163.8	1.64
S-16	3.44	79.85	338.82	1.38	23.96	2.9	43.29	170.17	1.39
S-17	2.76	79.34	342.36	1.13	0.53	2.78	41.37	169.26	1.24
S-18	2.83	90.89	328.78	1.41	24.5	3.1	44.58	191.1	1.27
S-19	3.72	80.23	337.8	1.63	24.89	6.14	40.03	162.89	1.56
S-20	7.51	108.22	299.75	0.79	27.61	9.73	48.45	182	1.51
Avg value	8.11	104.85	300.29	0.86	26.2	10.18	54.32	179.68	0.97
World Avg	0.8	3			1.6	0.9	3.46	68	558
Min. value	2.76	78.69	268.83	0.33	0.53	2.78	40.03	16.38	0.37
Max. value	20	152.98	342.36	1.65	34.49	22.79	68.21	277.55	1.64
SD	5.66	19.88	23.65	0.41	7.09	6.55	8.99	63.672	0.42
CV	0.7	0.19	0.08	0.03	0.27	0.64	0.17	0.35	0.43

3.4 Magnesium (Mg)

From the analysis it has been observed that Mg shows great variation in the study area. Sample no 1, 2, 3 showed greater values than other values. Values ranges from 2.76 to 20 mg/kg with mean value 7.78 mg/kg which is higher than the world average value (0.8 mg/kg). Major sources of Mg in secondary minerals, including carbonates for example, dolomite $[MgCO_3, CaCO_3]$, magnesite $[MgCO_3]$, talc $[Mg_3Si_4O_{10}(OH)_2]$, and the serpentine group $[Mg_3 Si_2 O_5 (OH)_4]$ are derived from these primary minerals. High Mg concentrations lead to poor plant growth and poor soil physical conditions (Mikkelsen 2010).

3.5 Aluminium(Al)

Values of Aluminium are much higher than the world average in all of the samples examined. Al values ranging from 78.69 mg/kg to 152.98 mg/kg in the samples whereas mean value is 103.75 mg/kg. World average value has been determined 3 mg/kg. Aluminum is used in beverage cans, pots and pans, siding, roofing and foil industries in study area. Aluminum compounds are used in many diverse and important industrial applications such as alums (aluminum sulfate) in water-treatment and alumina in abrasives and furnace linings (ATSDR 2008). Dietary organically complexed Aluminium, maybe in synergistic effects with other contaminants, may easily be absorbed and interfere with important metabolic processes in mammals and birds. The mycorrhiza and fine root systems of terrestrial plants are adversely affected by high levels of inorganic monomeric Aluminium. As in the animals, Aluminium seems to have its primary effect on enzyme systems important for the uptake of nutrients. Aluminium can accumulate in plants. Aluminium contaminated invertebrates and plants might thus be a link for Aluminium to enter into terrestrial food chains.

3.6 Silicon (Si)

Silicon is evenly distributed in the study area show low variation in concentration. The average value of Silicon is 299.76 mg/kg with a range from 268.83 to 342.36 mg/kg in all samples. Because of the wide range of possible forms, silicon has extensive industrial applications. Silicone rubber is used effectively in computers and electronics, automobiles, textiles, healthcare products, construction and architecture, and household products—numerous materials we come in contact with on a daily basis, including even hair conditioner, depend on silicone or silicon-based polymers. Potassium silicate is used in nutria-culture for disease control in some high value crops. Sodium silicate and silica gel have also been used to supply Si in research and high value crops. Calcium silicates have emerged as the most important sources for soil applications. Of those, calcium *meta*-silicate (wollastonite, $CaSiO_3$) has been the most effective source in many locations with low concentrations of soluble-Si in soils (Gary 2001).

3.7 Phosphorous (P)

Phosphorous concentration shows high level of variation in the study area range from 0.33 to 1.65 mg/kg which mean value is 0.85 mg/kg. The elementary phosphorus is used in several pyrotechnic applications (fireworks, luminous projectiles or in commonly denominated matches), in the metallurgical industry to form metallic alloys as the phosphorous brass, in the production of insecticides or as additive of industrial oils. The phosphoric acid is used as additive for certain drinks as well as in the cleaning of some metals or as phosphatizing agent. But it is in the form of phosphate salts that the element has the largest applications. The fertilizer industry almost absorbs all extracted phosphates of the rocks. There are several types of fertilizers obtained from phosphates, usually mixed with potash or ammonia salts. The phosphate salts are also used in the production of synthetic detergents (sodium polyphosphate) and in teeth paste (calcium phosphate). White phosphorus is extremely poisonous and in many cases exposure to it will be fatal. White phosphorus can cause skin burns. While burning, white phosphorus may cause damage to the liver, the heart or the kidneys (Lenntech 1993).

3.8 Potassium (K)

Potassium (K) is one of the three major nutrients needed by plants, the others being nitrogen (N) and phosphorus (P). In the soil environment, potassium exists in three different forms. Plants only absorb potassium ions (K^+) in one form called exchangeable potassium, provided by moist clay particles or organic matter. When discussing only plant-available potassium, the potassium ion is positively charged and is most easily absorbed into roots when the soil is not dry or pH not alkaline (Burghardt 2015). Values of Potassium are higher than the world average (1.6 mg/kg) except near Prottasha bridge area which is lower than the standard. Values range from 0.53 to 34.49 mg/kg with an average value 27.07 mg/kg. Higher values may be because of mineral Potash Alumino Silicate and fertilizer used for nutrient amendment. High rates of potassium fertilizer can cause salt burn (Exchangeable Calcium and Magnesium). Soils with high potassium levels can induce causes high osmotic pressure in soils, slows bacterial growth and multiplication, causes poor fertilizer efficiency, reduces uptake of

calcium, magnesium, and boron, causes leafy and stalk vegetables to be tough and stringy, causes alkaline soils unless excessive chlorine is present.

3.9 Calcium (Ca)

Calcium is very important element for plant growth. Values are higher than the world standard (0.9 mg/kg) which ranges from 2.27 mg/kg to 22.79 mg/kg with average value 9.92 mg/kg. Calcium is available from different minerals and industrial sources. Excess amount of Ca increases the need for phosphorus and zinc, decreases the availability of nitrogen, phosphorus, iron, manganese, zinc, potassium, and hampers the buildup of potassium, increases calcium content of food and feed grains.

3.10 Iron (Fe)

From the assessment it has been found that Iron concentration is higher than the world average (3.46 mg/kg) which are ranges from 40.03 to 68.21 mg/kg with an average value of 54.34 mg/kg. The ferrous form is active and easily absorbed. Higher levels of Fe in the study area because Madhupur clay minerals contain higher level of Fe in soil itself and Fe alloy is used in industries. Soil pH and aeration influence the availability of the iron. Iron availability in soil decreases as the pH of the soil increases. Higher level of Fe can interfere with phosphorus absorption, requires use of higher levels of potassium to regulate and can cause Zinc deficiency.

3.11 Rubidium (Rb)(Simuet al.2016)

The average content of Rb in soil examined was 179.68 mg/kg with minimum and maximum ranges from 16.38 to 277.55mg/kg. Rubidium concentration is found to be lower than the world average (68 mg/kg) at location Darun bazar and found higher at kalakor, beside turag river, mazipara beside turag river of the study area due presence of metal processing industries and glass, ceramics industries. The metal is used in the manufacture of photocells and in the removal of residual gases from vacuum tubes. Rubidium salts are used in glasses and ceramics and in fireworks to give them a purple color (Lenntech 1993). Rubidium has no extensive application in the industries. The relative abundance of rubidium has been reassessed in recent years and it is now suspected of being more plentiful than previously calculated. No minerals of rubidium are known, but rubidium is present in significant amounts in other minerals such as lepidolite (1.5%), pollucite and carnallite. It is also present in traces in trace amounts in other minerals such as zinnwaldite and leucite.

3.12 Manganese (Mn)

From the analysis it is evident that Manganese value is very much lower than the world average (558 mg/kg). Manganese value range from 0.37 to 1.64 mg/kg with the average value 0.96 mg/kg. Mn conc. is very much insufficient required for plants. Similar to iron deficiency, Mn deficiency syndrome is yellowing between the veins of youngest leaves. Usually only the main veins remain green causing a fishbone-like appearance. In some plants older leaves may develop gray streaks or dots. Occur on organic soils with pH greater than 6.0 (Exchangeable Calcium and Magnesium).

3.13 Cluster Analysis

An explorative hierarchical cluster analysis was performed on measured dataset with Ward's method and the Pearson r as a similarity measure in order to discriminate distinct groups of metals as tracers of natural or anthropogenic source (Manta et al. 2002). From cluster analysis it is found that there are two main clusters(1 and 2) among the elements under several sub-groups. In group 1 there are most of the elements e.g: OC, OM, Si, pH, Moisture, Fe, K,Al, Rband in group 2 there are P,Mn, Mg , Ca. Group 1 is divided into several sub-groups. Group 1 contains mainly geological sources but also extensively used in industrial purposes.Organic carbon, organic matter are closely related with each other and mostly come from common sources. Si, Fe, Al are regularly used in in industry or in agriculture.Si, Fe, K, Al, Rb are showing pH, moisture content dependency. Group 2 contains elements which are frequently used in industrial activities or in agricultural purpose.

* * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * *

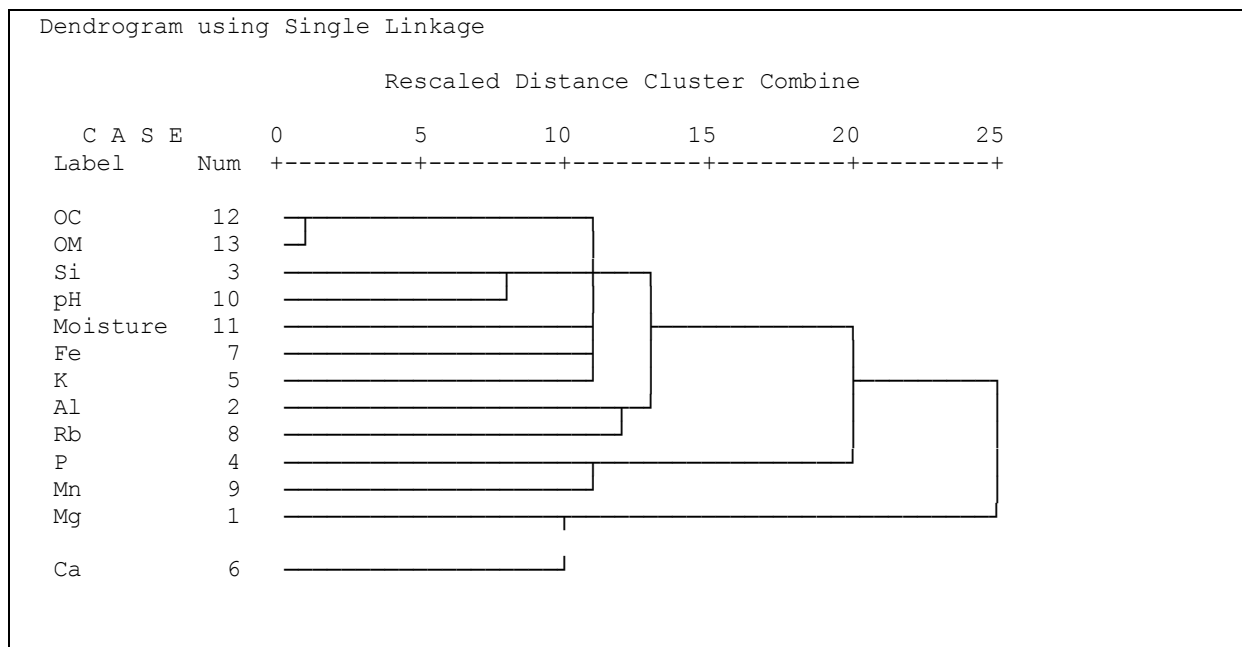


Figure 2: Hierarchical Cluster Analysis of the components

3.14: Correlation Matrix

Correlation matrix was performed to analyze the mutual relationship of the elements. As there are many common sources of the element in nature, so there are obviously positive co-relationship among them. Si-P, K-Mg, Ca-Mg, Fe-Mg, Fe-K, Fe-Ca, Rb-Al, Mn-Si, Mn-P, OC-Si, OC-OM are showing significant positive relationship which indicate common sources. There are different minerals in environment which contain mixture of elements in different ratio. Most of the elements having positive correlation are mainly come from anthropogenic sources but the portion of natural sources is not negligible.

Table 3: Correlation Matrix showing mutual relationship among the components

	Mg	Al	Si	P	K	Ca	Fe	Rb	Mn	pH	Moisture	OC	OM
Mg	1												
Al	-.171	1											
Si	-.475*	-.728**	1										
P	-.121	-.862**	.851**	1									
K	.567**	.256	-.644**	-.321	1								
Ca	.890**	-.227	-.478*	-.070	.586**	1							
Fe	.665**	.347	-.845**	-.599**	.624**	.706**	1						

Rb	-.520**	.616**	-.208	-.361	-.066	-.505*	-.055	1					
Mn	.115	-.821**	.642**	.851**	-.189	.168	-.355	-.374	1				
pH	-.017	.330	-.256	-.342	.059	-.061	.117	.031	-.280	1			
Moisture	.110	-.417*	.380*	.361	-.247	-.038	-.217	-.260	.500*	.318	1		
OC	-.669**	-.072	.588**	.334	-.551**	-.638**	-.783**	.000	.108	.090	.170	1	**
OM	-.669**	-.072	.587**	.334	-.551**	-.638**	-.783**	.000	.108	.091	.171	1.000**	1

3.15 Principal Component Analysis:

From the Component Matrix it is elucidated that component 1 includes Si, P, Mn, OC, OM, Moisture which is very common and very crucial for soil matrix. These are the major components for soil matrix formation. Without these components soil quality will be remarkably changed and plant growth will be prohibited. Component 2 involves mainly Mg, P, Ca, Mn, Fe elements, Component 2 elements are greatly used in agricultural activities as well as in industrial activities. Component 3 includes Mg, pH, OC, OM in soil matrix. These are very important components as soil quality greatly depend on the character. Scree plot is clarifying the component matrix that 3 components are crucial for soil matrix formation.

Table 4: Component Matrix in Soil

	Component		
	1	2	3
Mg	-.651	.662	.164
Al	-.505	-.824	.077
Si	.937	.260	-.102
P	.721	.601	-.161
K	-.732	.181	-.015
Ca	-.644	.675	.057
Fe	-.929	.142	.059
Rb	-.063	-.721	-.284
Mn	.507	.742	-.045
pH	-.138	-.286	.861
Moisture	.361	.378	.657
OC	.807	-.347	.200
OM	.807	-.347	.202

Extraction Method: Principal Component Analysis.

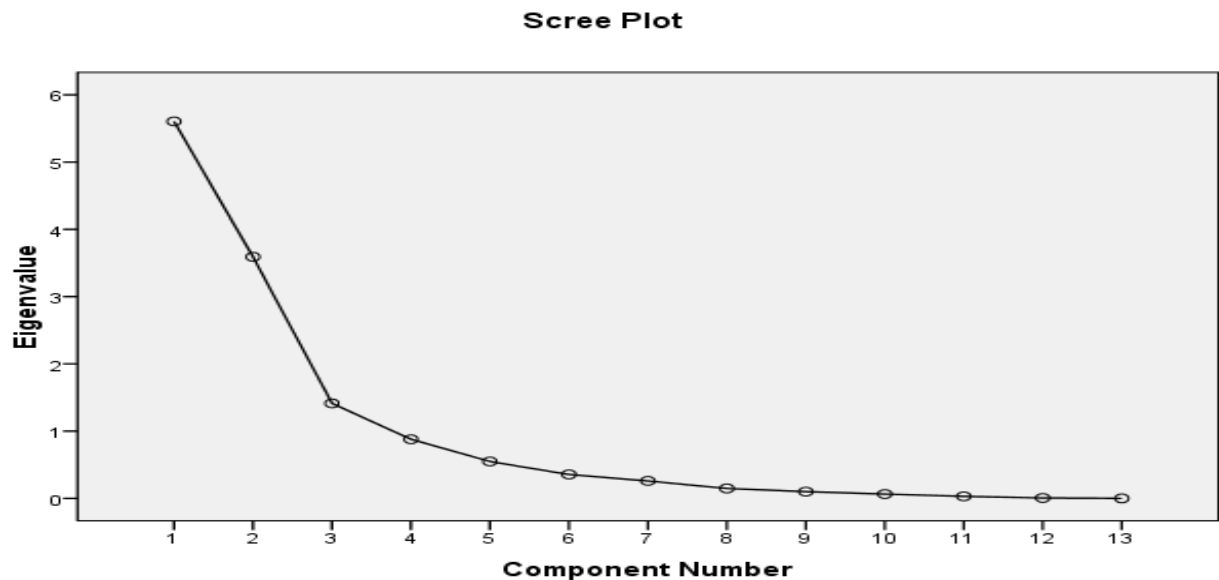


Fig 3: Scree plot of Principal Component Analysis

IV. Conclusion:

As soil samples were analyzed to specify soil elements, it is investigated that some elements are remained within the world average and others are unfortunately exceeded the world standard level. Among the analyzed components Mg, Al, K, Ca, Fe, Rb exceeds threshold level of environment and others are in the limit. Exceeding concentration of the elements may negatively interfere with plant growth and development. Cluster analysis illustrating two major clusters which indicate their common sources or allure for each other. Correlation matrix is showing significant positive relation among themselves. Limit exceeding components are frequently used as agro-chemicals and industrial raw materials in process industries. Though they are crucial for soil microbes but when threshold limit exceeds it may be lethal for the biosphere. The food chain can be interrupted by the imbalance condition of the soil matrix. Important bio-chemical reaction of the soil is hampered thus following changes effects on biosphere. It is obvious that they are required for soil nutrient but should be maintained the standard to comply the basic reactions in soil matrix.

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